10/537941

JC20 Rec'd PCT/PTO 03 JUN 2005

Mechanism for securing together building modules

DESCRIPTION

Field of the Invention

The invention relates to modular building units for use in the construction of largely prefabricated offices, hotels and apartment blocks, and buildings of a similar general nature. Such modular building units are box-like structures which can be manufactured and fitted-out off-site and then transported to a construction site for final assembly to form the internal rooms of a building. The building is assembled by stacking the individual modules in a horizontal and vertical array and securing them together to form a rigid structure. The invention provides a novel mechanism for securing the adjacent modules together.

Background Art

Particularly in the construction of hotels, apartments and student accommodation it is known to construct the buildings from lightweight building modules each of which is a skeletal steel shell formed from lightweight structural steel sections welded into a box-like structure and lined with boarding such as plasterboard, plywood or oriented strand board (OSB). Each building module is made initially as such a lined shell, and is then fitted-out to the desired standard of internal decoration in a factory before being transported to the final building site for incorporation into a building.

Individual building modules for erection in a horizontal and vertical array into such a building are described and claimed in copending Patent Application No W068004. Other building modules are known, made primarily from wood frames and wood boarding.

A difficulty arises in the securing together of the individual modules. A first module can be swung into position by crane and bolted or otherwise secured

to the building foundations. A next module can then be swung into position alongside, but the edge that lies alongside the foundations immediately adjacent to the original secured module is obscured from access, and only the accessible sides of the base of the module can be secures to the foundations. Similarly with all subsequent storeys of the building, only the first module to be swung into position can be secured on all bottom edges. All subsequent modules have at least one bottom edge obscured by the adjacent module or modules, so securing is limited to those non-obscured edges.

The invention

The invention provides a mechanism for securing together room-sized building modules in the construction of a building as claimed in the claims herein. The mechanism can be used in the securing of the first course of building modules to a foundation or base structure, or for the securing of any subsequent course to the course below. The resulting building is one in which each building module is secured along both long sides and preferably along all sides to the adjacent structure in both the vertical and horizontal directions.

Drawings

Figure 1 is a schematic perspective view of eight building modules stacked in a 2x2x2 vertical and horizontal array typical of a part of a modular building constructed from such modules;

Figure 2 is a vertical section through a first embodiment of a securing mechanism according to the invention securing together four of the modules of Figure 1;

Figure 3 is a perspective view of a part of the securing mechanism of Figure 2;

Figure 4 is a vertical section through a second embodiment of a securing mechanism according to the invention for securing together two horizontally adjacent modules of Figure 1, although the side fixing of only one of those modules is shown in Figure 4 for clarity; and

Figure 5 is a perspective view of the mechanism of Figure 4.

Referring first to Figure 1, there is shown schematically a part of a building constructed from modular building units such as those, for example, described and claimed in copending Patent Application No W068004. The modules are shown in a 2x2x2 array, although in a complete building the array could be much larger. Rooms two deep are a common feature of such buildings, as the outside walls of the modules can be pre-fitted with external windows. The internal walls can be provided with connecting doors or corridor sections, to make up the floor plans familiar to all those aware of modern hotel bedroom layouts. The number of modules in each corridor is dependent on the size of the site only, and the height of the building is governed only by the strength of the individual units and the rigidity and load-bearing capacity of the lower units.

In Figure 1 three modules 1, 2 and 3 of the four modules of the ground floor are visible. A fourth ground floor module, which would have carried the reference 4, is hidden from view. On the floor above, however, all four modules 5, 6, 7 and 8 are shown.

If the individual modules were hoisted into position in the above numerical sequence, it will be appreciated that module 1 can be fixed to the foundations (or to the floor below if the illustration was at a higher level in the building) on all four of its base edges, because none of those edges is obscured by an adjacent module when module 1 is the only one on site. When module 2 is hoisted into position alongside, however, it cannot be secured to the foundations or lower course along its short bottom edge that abuts module 1. It has in the past been secured only at the other, exposed, bottom edges. Similarly module 3 has been secured only along two short and one long base edge; and module 4 would have been secured only along one long and one short edge. Exactly the same restrictions apply when hoisting modules 5 to 8 into position and securing them to modules 1 to 4.

Figures 2 and 3 show a fixing mechanism according to the invention which secures all of the modules along all of their edges or sides in both the vertical and horizontal directions. The four building modules shown are modules 1, 2, 5 and 6 of Figure 1, but of course any adjacent set of four modules could be connected together in the same way. The corner detail of the individual modules is as described and claimed in copending Patent Application No W068005. Each of the mutually facing vertical walls of the individual modules is shown as being of double thickness, with the outermost wall of each module being given the reference 10. The showing of the walls as double thickness is of no relevance to this invention, and is merely a reflection of the fact that the individual building modules, which may be as described and claimed in copending Patent Application No W068004, are make from a skeletal framework lined internally and finished by fitting-out before being transported to the building site.

What is of importance to this invention is that each module has secured to its outer wall a metal channel member 11 of top-hat section which extends around the outside of the module along each wall that in the finished building is to face the wall of an adjacent module. One such channel member 11 is secured around the top of each module as shown for the modules 1 and 2; and one is secured around the bottom of each module as shown for modules 5 and 6. Each individual module therefore has two such channel members 11 around its periphery or part of its periphery, one at a low level and one at a high level. Each channel member 11 is parallel to the adjacent corner of the module and spaced from that corner by a constant spacing **d.**

When the modules are stacked together there is a small but constant spacing between the adjacent vertical walls. This is a necessary requirement for acoustic insulation, and is utilized in the fixing mechanism of the invention. A link means 12 is inserted into the spacing left between the adjacent modules 1 and 2 as shown in Figure 2, and is then secured to the tops of those two modules before the modules 5 and 6 are swung into position. The link means

12, shown more clearly in Figure 3, comprises a base strip 13 of galvanized steel upstanding from which are a regular array, along the length of the base strip, of resiliently flexible legs 14 each having a detent flange 15 formed along its upper and outer edge. Below the base strip 13 is a symmetrically similar regular array of resiliently flexible legs 16 each having a detent flange 17 formed along its lower and outer edge. The vertical spacing between base strip and the flanges 15 and 17 is the distance **d**.

When the link means 12 is inserted into the gap between the adjacent modules 1 and 2, the legs 16 flex inwardly until the flanges pass under the channel members 11, and then spring outwardly under their own resilience to hold the link means firmly down with its base strip 13 abutting the top surface of the adjacent modules 1 and 2. The base strip 13 is then secured along its long edges to the modules 1 and 2 below, for example by screws. Self-tapping screws into the structural steel framework of the modules gives a string fastening; or alternatively the base strip could be plug welded or seam welded to a peripheral channel in the top edges of the modules. Shown in Figure 3 at 18 are the locations of the screws or plug welds.

When secured as above, the modules 1 and 2 are fastened together along their top edges in both the vertical and horizontal planes by the link means 12. Moreover, the upstanding resiliently flexible legs 14 and detent flanges 15 are positioned to engage with the lower channel members 11 of the next level of modules 5 and 6 as they are hoisted into position. As each of the modules 5 and 6 is lowered into position onto the tops of the modules 1 and 2, the resiliently flexible legs flex and return with their detent flanges 15 engaging above the channel member 11 of the associated module, providing secure attachment of the next layer of modules around all edges of each module, top and bottom.

The base portion 13 of each insert 12 has another important function. It completely covers and closes the gap between adjacent modules. Therefore

when the modules are being erected on site there is only a short time during which rain or dirt can travel down between adjacent modules, which is a highly desirable feature on the building site itself. Also, on completion of the building the creation of a continuous chimney or void from base to roof of the finished building is avoided, which is a great advantage from a fire security viewpoint. In Figure 3 the base strip 13 is shown flat. However a preferred form is to shape the base strip as a gutter, so that any rain falling on the building modules during erection of the building is channelled away to one end or the other of the building.

It will be understood that suitable acoustic insulation will be provided in practice between the adjacent modules and between the modules and the inserts 12, although none is shown in the drawings. For example, an acoustic barrier could be created between adjacent modules by placing a layer of acoustically insulating material such as neoprene foam between the outer walls 10 of each module and the channel members 11; or by covering the outer surface of the channel members 11 with similar material.

Figures 4 and 5 show an alternative securing mechanism according to the invention. Each module has on its outer wall 10 a series of guide channels 21. Each guide channel 21 is mounted on a fixing plate 22 which is secured to the outer wall 10 for example by welding or by screwing or bolting through an acoustically insulating layer (not shown). Each guide channel 21 is offset outwardly from its fixing plate 22 by a distance **d1** (Figure 4) in the direction of the adjacent modules in the building. The distance **d1** is less than half of the spacing that is left between the adjacent modules when the are hoisted into position in the final building as illustrated in Figure 1, so that in the final building there is a space between the adjacent and mutually aligned guide channels 21.

Each guide channel has a guide slot 23 formed in its outer face, extending from a divergent jaw 24 to a parallel-sided cup portion 25. Secured at the

bottom of the fixing plate 22, and lying inside the guide channel 21, is a resiliently deformable sheet of spring steel 26 which acts as a detent for a connecting pin 27 which will be described later. A circular aperture 28 in the spring detent 26 is positioned to lie alongside the bottom of the cup portion 25 of the guide channel 23 to receive an end of the connecting pin 27.

The connecting pin 27 is located on a lower end of an insert bar 29. When two modules of a single storey of a building are in their final positions adjacent one another as shown in Figure 1 for example, the guide channels 21 of those two modules are immediately adjacent on another. The insert bar 29 is lowered into the gap between the adjacent modules and the pin 27 is guided by the divergent jaws 24 into the cup portions 25 of the two adjacent guide channels 21. As the inset bar 29 is lowered, it bends the spring steel detents 26 inwardly, but springs back with the ends of the pin 27 received in the circular aperture 28. The spring steel detents 26 prevent the pin 27 from moving in the vertical direction, and shoulders 30 of the pin 27 engage behind the wall of the guide channels 21 defining the cup portions 25 to prevent lateral movement of one building module relative to the other.

The guide channels 21 may be provided at any location and at any height on the mutually facing outer sides of the building modules. If they are provided at a low level, near to the base of the modules, then it may be desirable to incorporate additional guide means to facilitate the engagement of the pin 28 in the guide channels 21 as the insert bar is lowered from the top of the adjacent modules.

Desirably as each level of the building is completed a cover strip of steel is secured over the small gap between adjacent modules, to keep out the weather on site before the building is finished and to act as a fire break in the finished building. Such a cover strip also assists in the securing together of the adjacent modules, as it connects together the top edges of the adjacent modules in the horizontal plane. The invention therefore embraces a building

method in which such a metal sheet, with a gutter formed therein, is secured over the junctions between the tops of adjacent modular building units in the building at each storey. Preferably the gutters formed in those metal sheets conduct rain water and/or condensation to the outside of the building.